

REMARKS

The applicants have amended claims 39 and 43 to clarify the same and provide adequate coverage for the invention. The claim has not been narrowed in scope and no new matter has been added. Claims 1-3, 6-35 and 37-43 are currently pending in the subject application.

Claim Rejections - 35 USC § 103

1. Claims 1-3, 6-10, 19, 20, 23, 24, 27-32, and 38-42 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Calderon, U.S. Patent No. 5,063,732 (hereinafter "Calderon '732"), in view of Anwer et al, U.S. Patent No. 4,017,272 (hereinafter "Anwer").

With regard to claim 1, the Examiner asserts that Calderon '732 discloses a process for producing energy from coal comprising: delivering coal via a packing ram 37 to an accumulator (chamber) 38 where pyrolysis tubes 40 are charged with coal and heated to drive volatile matter out of the coal; the volatile matter (a rich gas) is collected and residual char remaining after the pyrolysis of the coal is discharged into a gasification vessel 47 where gasification vessel 47 receives a supply of an oxidant through tuyeres 48 to gasify the residual char, and slag is discharged through a nozzle 49; a duct 52 is provided to collect the gas produced from the gasification of char, which is known as a lean gas; the lean gas is passed through a cyclone 53 which serves to remove particulate matter (such as slag, a resulting product of gasifying the char, thus the lean gas and slag flow out of the gasification vessel through a common port) from

the lean gas prior to its clean up; the rich gas from duct 44 enters a cracker 56 which serves to crack and desulfurize the rich gas to yield a clean syngas (Referring to Col. 4, lines 33—68 and Col. 5, lines 1-41; Figs. 4 and 5).

It is acknowledged that Calderon '732 does not disclose injecting essentially pure oxygen in such a way as to combust a portion of the coal while maintaining a pressurized reducing atmosphere to yield a rich gas. Calderon '732 discloses the use of pyrolysis to thermally volatize the coal to make a rich gas (See Col. 3, lines 42-42). Anwer is said to disclose a process for gasifying carbonaceous material under selective conditions to produce a gaseous product rich in carbon monoxide and hydrogen (a rich gas) comprising introducing in the gasifier particulate carbonaceous material at a pressure above the pressure of the gasifier, introducing oxygen-containing gas with up to about 50 percent (vol.) of steam, gasifying the carbonaceous material to produce a gaseous reaction product in conjunction with spent char (See Col. 22 lines 10-57). Anwer further discloses the reactions in the gasifier are advantageously conducted under pressure (See Col. 6, lines 64-68). The raw product gas resulting from the gasification reaction has a superficial velocity (thus pressurized), as a function of operating pressure (See Col. 8, lines 29-38).

The Examiner concludes that, at the time of the invention, it would have been obvious to a person of ordinary skill in the art to modify Calderon '732 by substituting the coal pyrolysis reaction to make a rich gas and char with the step of partial combustion of coal with oxygen under pressure as disclosed in Anwer for the same purpose, to produce a rich gas and char.

With regard to independent claim 39, it is simply asserted that Calderon '732 further discloses that the lean gas can be used in turbines to generate electrical power and the syn gas (rich gas) can be converted to a marketable chemical (See Claim 1).

Regarding the remaining claims, each of which is dependent upon either claim 1 or claim 39, the Office Action sets forth portions of either Calderon '732 or Answer said to disclose the additional limitation(s) claimed.

2. Claims 11, 12 and 14-17 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Calderon '732, in view of Answer, as applied to claim 1 and in further view of Tanca U.S Patent No. 4,445,441 (hereinafter "Tanca").

3. Claims 13, 25 and 26 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Calderon '732 in view of Answer, as applied to claim I, further in view of Tanca as applied to claim 11, and further in view of Calderon, U.S. Patent No. 5,136,808 (hereinafter "Calderon '808").

4. Claim 18 is rejected under 35 U.S.C. 103(a) as being unpatentable over Calderon in view of Answer, in further view of Tanca, and further in view of the Kawai et al. U.S. Patent No. 2,971,830 (hereinafter "Kawai").

5. Claim 21 has been rejected under 35 U.S.C. 103(a) as being unpatentable over Calderon '732 in view of Anwer, as applied to claim 20 as set forth above, and in further view of the Calderon et al. U.S. Patent No. 6,409,790 (hereinafter "Calderon '790").

6. Claims 22 and 33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Calderon '732 in view of Anwer as applied to claim 1 as set forth above, and in further view of the Kevorkian et al. U.S. Patent No. 3,976,548 (hereinafter "Kevorkian").

7. Claims 34 and 35 are rejected under 35 U.S.C. 103(a) as being unpatentable over Calderon '732 in view of Anwer, as applied to claim 1 and in further view of the Paisley U.S. Patent No. 5,494,653 (hereinafter "Paisely").

8. Claim 43 stands rejected under 35 U.S.C. 103(a) as being unpatentable over Calderon '732 in view of Anwer, and in further view of the Gorbaty U.S. Patent No. 4,113,615 (hereinafter "Gorbaty '615").

It is asserted that Calderon '732 discloses a process for producing energy from coal comprising: delivering coal via a packing ram 37 to an accumulator (chamber) 38 where pyrolysis tubes 40 are charged with coal and heated to drive volatile matter out of the coal; the volatile matter (a rich gas) is collected and residual char remaining after the pyrolysis of the coal is discharged into a gasification vessel 47 where gasification vessel 47 receives a supply of an oxidant through tuyeres 48 to gasify the residual char, and slag is discharged through a nozzle 49; a duct 52 is provided to collect the gas

produced from the gasification of char, which is known as a lean gas; the lean gas is passed through a cyclone 53 which serves to remove particulate matter (such as slag, a resulting product of gasifying the char, thus the lean gas and slag flow out of the gasification vessel through a common port) from the lean gas prior to its clean up; the rich gas from duct 44 enters a cracker 56 which serves to crack and desulfurize the rich gas to yield a clean syngas (Col. 4, lines 33-68 and Col. 5, lines 1-41; Figs. 4 and 5).

It is acknowledged, however, that Calderon '732 does not disclose injecting essentially pure oxygen in such a way as to combust a portion of the coal while maintaining a pressurized reducing atmosphere to yield a rich gas. Calderon '732 discloses the use of pyrolysis to thermally volatilize the coal to make a rich gas (See Col. 3, lines 42-42). Answer is said to disclose a process for gasifying carbonaceous material under selective conditions to produce a gaseous product rich in carbon monoxide and hydrogen (a rich gas) comprising introducing in the gasifier particulate carbonaceous material at a pressure above the pressure of the gasifier, introducing oxygen-containing gas with up to about 50 percent (vol.) of steam, gasifying the carbonaceous material to produce a gaseous reaction product in conjunction with spent char (See Col. 22 lines 10-57). Answer further discloses the reactions in the gasifier are advantageously conducted under pressure (See Col. 6, lines 64-68). The raw product gas resulting from the gasification reaction has a superficial velocity (thus pressurized), as a function of operating pressure (See Col. 8, lines 29-38).

It is further acknowledged that these references do not disclose separating the rich cracked gas from coke (or char) to yield coke (or char) usable in the field of

metallurgy. However, Gorbaty '615 is asserted to disclose the carbonaceous product resulting from the thermal processing of coal (gasification), in those cases where the coal is not completely consumed or converted, exhibit adsorption properties similar to commercially available activated carbon and suggests that these chars may be used to treat waste water (See Col. 1, lines 54-67). The Examiner therefore concludes that, at the time of the invention, it would have been obvious to a person of ordinary skill in the art to modify Calderon '732 by substituting the coal pyrolysis reaction to make a rich gas and char with the step of partial combustion of coal with oxygen under pressure as disclosed in Anwer, for the same purpose to producing a rich gas and char; and it would have been further obvious to modify the combination of Calderon '732 and Anwer with Gorbaty '615 for the purpose of using the spent char (coke) in the field of metallurgy instead of gasification of the char. Gorbaty '615 suggests the motivation to combine because one skilled in the art would readily recognize the properties of the char are similar to commercially available activated carbon (thus useful in the metallurgy field) and such product would enhance the economics of the gasification process (See Col. 2, lines 1-10).

9. Claim 37 has been rejected under 35 U.S.C. 103(a) as being unpatentable over Calderon '732 in view of Anwer, and in further view of Gorbaty '615, and further in view of the Gorbaty et al. U.S. Patent No. 4,113,602 (hereinafter "Gorbaty '602").

Response to Claim Rejections - 35 USC § 103

1. Applicants respectfully traverse the rejections of claims 1-3, 6-10, 19, 20, 23, 24, 27-32, and 38-42 as being unpatentable over Calderon '732 in view of Anwer.

Applicants' invention, as defined in claim 1, is a method for producing clean energy from coal comprising feeding coal into a chamber which is sealed to the atmosphere and which possesses a charging end and a discharging end, moving the coal within said chamber towards the discharging end, injecting oxygen which is essentially pure in such a way as to combust a portion of the coal while maintaining a pressurized reducing atmosphere to: (i) cause the release of thermal energy to devolatilize the coal, and (ii) yield a pressurized hydrogen rich raw gas containing coal-derived cancer causing distillates and hydrocarbons together with a hot char. The coal-derived cancer causing distillates and hydrocarbons contained in the hydrogen rich raw gas are cracked to make a hydrogen rich cracked gas which, after desulfurization, becomes a clean hydrogen rich synthesis gas. The hot char is directed to a gasifier which is sealed to the atmosphere, and is gasified with an oxidant in said gasifier to yield a raw second gas and a molten slag. The raw second gas is flowed together with the molten slag through a common port out of said gasifier to maintain said port open for the free flow of the raw second gas and the molten slag, and the raw second gas is separated from the molten slag after exiting from said common port. The raw second gas is directed to a cleanup system to clean it and thus yield a clean second gas, and the molten slag is quenched to convert it to a non-leaching solid.

The Examiner takes the position that Calderon '732 teaches that "the lean gas is passed through a cyclone 53 which serves to remove particulate matter (such as slag, a resulting product of gasifying the char, thus the lean gas and slag flow out of the gasification vessel through a common port) from the lean gas prior to its clean up."

Thus, the Examiner takes the position that the Calderon '732 teaches or suggests that the slag may be blown out of the duct 52 along with the gas, essentially "flowing the raw second gas together with the molten slag through a common port out of said gasifier to maintain said port open for the free flow of the raw second gas and the molten slag," as required by claim 1.

It is respectfully submitted that this is an erroneous interpretation of the apparatus and method of Calderon '732. As noted at column 5 lines 3-6 of Calderon '732, "At the top of gasification vessel 47, a duct denoted by numeral 52 is provided to collect the gas produced from the gasification of the char." While it is further noted that the gas is passed through a cyclone 53 to remove particulate matter from the lean gas prior to its cleanup, the slag produced is heavier than the ash particulates which exit through the duct 52 with the lean gas. In fact, the focus of Calderon '732 is forcing the slag downward through the vertical gasification vessel, away from the duct 52 and out through the "slag discharge nozzle 49," and then through "a slag quenching hopper 50 and a slag lockhopper 51." (Column 4 lines 65-68, and see Figure 6). In fact, if one were to attempt to blow the molten slag of Calderon '732 up through the bed to the duct 52, the molten slag would freeze in the cooler, upper portions of the bed, rendering the system of Calderon '732 inoperative.

Accordingly, Calderon '732 fails to teach or suggest "flowing the raw second gas together with the molten slag through a common port out of said gasifier to maintain said port open for the free flow of the raw second gas and the molten slag," as required by claim 1. For this reason, the invention defined as in claim 1 is not unpatentable over Calderon '732 and Anwer, and the rejection should be withdrawn.

In addition, as correctly conceded by the Examiner, the primary reference (Calderon '732) does not disclose injecting essentially pure oxygen in such a way as to combust a portion of the coal while maintaining a pressurized reducing atmosphere to yield a rich gas, as required by claim 1. The Examiner attempts to overcome this deficiency by combining Calderon '732 with Anwer to establish a case of obviousness.

However, according to the MPEP, "[t]o establish a prima facie case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations." See MPEP 2143.

Moreover, in order to properly combine references in a rejection, it is well established that the function of the primary reference cannot be destroyed by combining it with the secondary reference. (see *In re Gordon*, 733 F. 2d 900, 221 USPQ 1125 Fed. Cir. 1984.) In this case, both Calderon '732 and the present invention are directed to fixed/moving bed reaction system, while Anwer is directed to

the use of a fluidized bed reaction system. In a fixed/moving bed, the coal is fed into the top of the gasifier and moves down as a packed, solid bed, and the coal/char is consumed at the bottom. In contrast, in a fluidized bed gasifier, the coal is kept in a constant state of agitation by a stream of hot gases passing up through a grid plate at the bottom of the gasifier. The resulting mixing, swirling behavior of the solids gives it the appearance of a bubbling liquid. See Attachment 1, copy of page 34 of "The U.S. Coal Gasification Program: Progress and Projects," Mechanical Engineering, August 1980, by C.L. Miller.

One skilled in the art would not attempt to combine the fixed/moving bed reaction system of Calderon '732 with the fluidized bed reaction system of Anwer. As a result, the two references are not properly combinable as proposed by the Examiner.

Furthermore, in the fixed/moving bed system of Calderon '732 and the invention, a molten slag is produced near the bottom of the vessel. Claim 1 of the present invention requires flowing the raw second gas together with the molten slag through a common port out of said gasifier. Anwer, however, specifically teaches away from the production of any molten slag in its fluidized bed system. Thus, at column 7 lines 35-41, Anwer indicates that, "generally up to about 60 percent (wt.) of partially spend (sic) char is removed from the bottom of the bed and is advantageously contacted with steam being introduced into the bed at the lower phase boundary to recover sensible heat from the char and preheat the steam." Of course, this removal of heat from the partially spent char prevents melting, the very thing required by Calderon '732 and the

present invention. For this additional reason, Calderon '732 and Anwer are not properly combinable as proposed by the Examiner.

For all of these reasons, claim 1 is not rendered unpatentable by Calderon '732 and Anwer, and the rejection should be withdrawn. Claims 2-3, 6-10, 19, 20, 23, 24, 27-32, and 38, 40 and 41 all depend, either directly or indirectly, from claim 1, and are patentable at least on the basis of this dependency from a patentable base claim.

Independent claim 39 defines a method for producing clean energy from coal in accordance with the invention comprising feeding coal into a chamber which is sealed to the atmosphere and which possesses a charging end and a discharging end, moving the coal within said chamber towards the discharging end, and injecting gas comprising oxygen in such a way as to combust a portion of the coal while maintaining a pressurized reducing atmosphere to: (i) cause the release of thermal energy to devolatilize the coal; and (ii) yield a pressurized raw gas containing coal-derived cancer causing distillates and hydrocarbons together with a hot char. The pressurized raw gas is directed in such a way as to emerge from the discharging end of said chamber, and the coal-derived cancer causing distillates and hydrocarbons contained in the raw gas are cracked to make a first cracked gas. The hot char is directed to a slagging gasifier which is sealed to the atmosphere and is gasified to make a second gas and a molten slag. The slag is removed from the system, and said first gas and said second gas are cleaned to provide clean gases for useful applications.

Calderon '732, discussed above, fails to teach or suggest injecting gas comprising oxygen in such a way as to combust a portion of the coal while maintaining a pressurized reducing atmosphere in the chamber to yield a raw gas. For all of the reasons discussed above relative to claim 1, Calderon '732 and Anwer are not properly combinable as proposed by the Examiner.

For these reasons, claim 39 is not rendered unpatentable by Calderon '732 and Anwer, and the rejection should be withdrawn. Claim 42 depends directly from claim 39, and is patentable at least on the basis of this dependency from a patentable base claim.

2. Claims 11, 12 and 14-17 all depend, either directly or indirectly, from claim 1, and are patentable at least on the basis of this dependency from a patentable base claim. Thus, the rejection under 35 U.S.C. 103(a) as being unpatentable over Calderon '732, in view of Anwer, and in further view of Tanca should be withdrawn.

3. Claims 13, 25 and 26 all depend, either directly or indirectly, from claim 1, and are patentable at least on the basis of this dependency from a patentable base claim. Thus, the rejection under 35 U.S.C. 103(a) as being unpatentable over Calderon '732, in view of Anwer and Tanca and further in view of Calderon '808, should be withdrawn.

4. Claim 18 depends indirectly from claim 1, and is patentable at least on the basis of this dependency from a patentable base claim. Thus, the rejection under 35 U.S.C.

103(a) as being unpatentable over Calderon '732, in view of Anwer and Tanca and further in view of Kawai, should be withdrawn.

5. Claim 21 depends indirectly from claim 1, and is patentable at least on the basis of this dependency from a patentable base claim. Thus, the rejection under 35 U.S.C. 103(a) as being unpatentable over Calderon '732, in view of Anwer and further in view of Calderon '790, should be withdrawn.

6. Claims 22 and 33 depend, either directly or indirectly, from claim 1, and are patentable at least on the basis of this dependency from a patentable base claim. Thus, the rejection under 35 U.S.C. 103(a) as being unpatentable over Calderon '732, in view of Anwer and further in view of Kevorkian, should be withdrawn.

7. Claims 34 and 35 depend, either directly or indirectly, from claim 1, and are patentable at least on the basis of this dependency from a patentable base claim. Thus, the rejection under 35 U.S.C. 103(a) as being unpatentable over Calderon '732, in view of Anwer and further in view of Paisely, should be withdrawn.

8. Claim 43 defines a method for producing clean energy from coal comprising feeding coal into a chamber which is sealed to the atmosphere and which possesses a charging end and a discharging end, moving the coal within said chamber towards the discharging end, and injecting gas comprising oxygen in such a way as to combust a

portion of the coal while maintaining a pressurized reducing atmosphere to: (i) cause the release of thermal energy to devolatilize the coal; and (ii) yield a pressurized raw gas containing coal-derived cancer causing distillates and hydrocarbons together with a hot coke. The coal-derived cancer causing distillates and hydrocarbons contained in the raw gas are cracked to make a cracked gas which, after desulfurization, becomes a clean gas. The cracked gas is separated from the coke to yield metallurgical coke.

The Examiner acknowledges that the primary reference, Calderon '732, fails to disclose injecting essentially pure oxygen in such a way as to combust a portion of the coal while maintaining a pressurized reducing atmosphere to yield a rich gas, but attempts to combine Calderon '732 with Anwer to overcome this deficiency. As discussed above, Calderon '732 and Anwer are not properly combinable as proposed by the Examiner.

Further, the Examiner concedes that Calderon '732 and Anwer (even if properly combinable) do not disclose separating the rich cracked gas from coke (or char) to yield coke (or char) usable in the field of metallurgy. However, it is asserted that Gorbaty '615 discloses the carbonaceous product resulting from the thermal processing of coal (gasification), in those cases where the coal is not completely consumed or converted, exhibit adsorption properties similar to commercially available "activated carbon" and suggests that these chars may be used to treat waste water (See Col. 1, lines 54-67).

However, the "activated carbon" like product taught by Gorbaty '615 is not the same as the "metallurgical coke" product defined by claim 43. As noted in the attached (Attachment 2) definition from page 1250 of the McGraw-Hill Dictionary of Scientific and

Technical Terms, Fifth Edition, metallurgical coke is "Coke resulting from high-temperature retorting of suitable coal; a dense, crush-resistant fuel for use in shaft furnaces." Metallurgical coke is vastly different from the softer, porous "activated carbon" like product, suitable as an adsorbent for waste water treatment, described in Gorbaty '615.

Thus, as the prior art reference (or references when combined) fail to teach or suggest all the claim limitations (See MPEP 2143), claim 43 is not rendered unpatentable over the Calderon '732, Anwer and Gorbaty '615, even if it were assumed that the three were properly combinable.

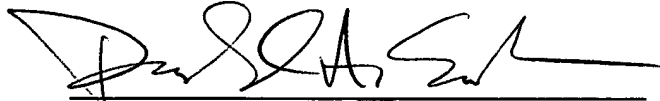
For all of these reasons, the rejection of claim 43 under 35 U.S.C. 103(a) should be withdrawn.

9. Claim 37 depends directly from claim 43, and is patentable at least on the basis of this dependency from a patentable base claim. Thus, the rejection of claim 37 under 35 U.S.C. 103(a) as being unpatentable over Calderon '732 in view of Anwer and Gorbaty '615, and further in view of Gorbaty '602, should be withdrawn.

Conclusion

For all the reasons set forth herein, applicants believe that the present application is now in condition for allowance, and a prompt action to that end is courteously solicited. If, however, the Examiner would prefer language different from that proposed herein, the favor of a phone call to applicants' attorney is respectfully requested.

Respectfully submitted,

A handwritten signature in black ink, appearing to read 'Donald A. Schurr', written over a horizontal line.

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The U.S. Coal Gasification Program:

Progress and Projects

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U.S. government development of gasification technology has been under way for a long time. It is currently being directed toward the use of state-of-the-art technology and the development of new and improved techniques that can improve conversion efficiency and reduce associated costs. Institutional problems may be as great a barrier to the implementation of a gasification industry as technological uncertainties. Also, a large number of support studies have been initiated concurrently to generate the technical base needed to solve future problems in these areas.

¹ Chief, Gasification Process Section.

Coal Gasification Terminology

1 Type of Reaction System Used in the Coal Gasifier, Fig. 1

(a) *Fixed/Moving Bed*—In this technique, the sized coal is fed into the top of the gasifier and moves down through the gasifier counter-current to the rising stream of hot gases as the coal is consumed at the bottom of the gasifier. Coal ash is discharged at the bottom and a coal-derived synthesis gas flows out of the top of this gasifier.

(b) *Fluidized-Bed Gasifier*—The coal fed to this gasifier is kept in a constant state of agitation by a stream of hot gases passing up through a grid plate at the bottom of the gasifier. The resulting mixing, swirling behavior of the solids gives it the appearance of a bubbling liquid; thus the name "fluidized bed."

(c) *Entrained-Bed System*—In this technique a finely pulverized coal is carried

into the reaction chamber by a stream of the reaction gases (i.e., steam and oxygen). The gasification of the coal occurs as it mixes and is swept through the reaction vessel.

The selection and use of one of these three systems is a process of trade-offs of the comparative advantages and disadvantages of each, Fig. 2.

2 Comparative Degrees of Technology Development

During the 1920s approximately 11,000 small gasifiers were in operation in the U.S. Today Lurgi, Koppers-Totzek, and other gasifiers are being used in many parts of the world to convert coal to a synthesis or fuel gas. By direct comparison, there are some gasifiers representing advanced concepts that are only at the bench-scale stage of development. In a simplistic attempt to

indicate the relative position that a particular gasification system occupies in this development process, the terms first-, second-, and third-generation have evolved:

(a) *First generation* designates state-of-the-art technology that exists and can be purchased from some company that will sell the gasifier and provide some degree of warranty about its performance. Examples of these gasifiers include Lurgi, Koppers-Totzek, Wellman-Galusha, Stoic, and Woodall-Duckham.

(b) *Second generation* is used to indicate those gasification systems currently in the pilot-plant stage of development or ready for demonstration as a commercial unit. Included among the members of this group are the HYGAS, BIGAS, Synthane, slagging Lurgi, Texaco, COGAS, and pressurized Koppers-Totzek gasifiers.

(c) *Third generation* refers to the newer

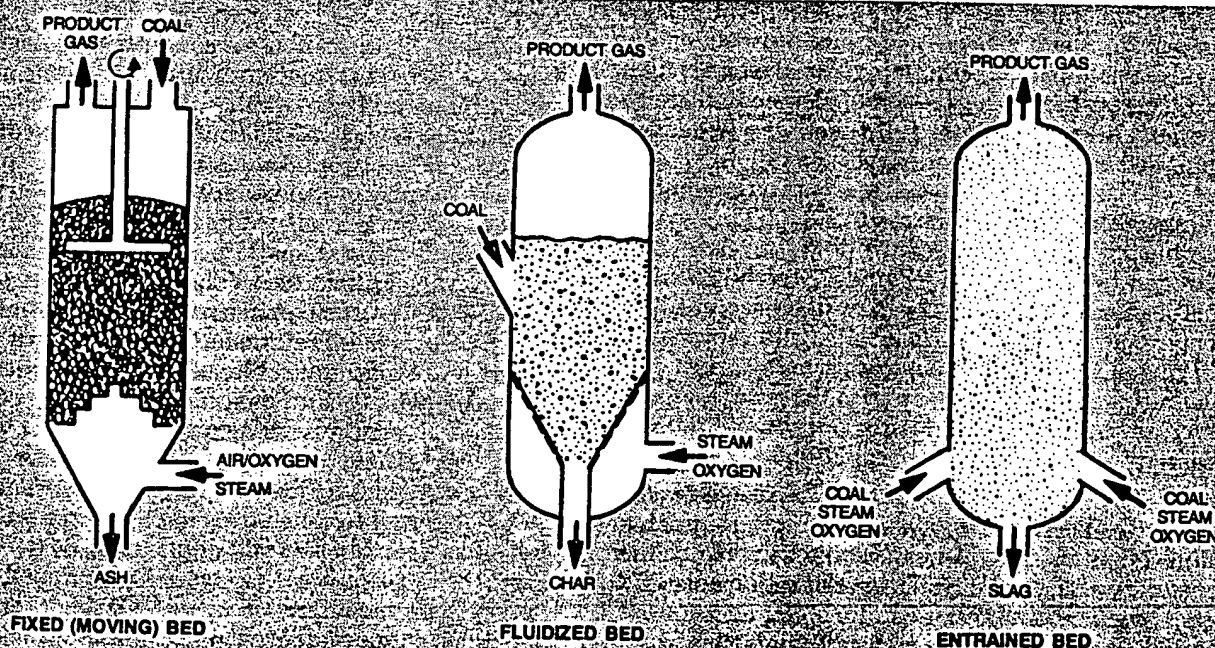


Fig. 1 Comparison of reactor bed configurations.

On the cover: Photomicrograph of crystals of vitamin B₁.
(Dennis Kunkel, University of Hawaii)

Included in this Dictionary are definitions which have been published previously in the following works: P. B. Jordain, *Condensed Computer Encyclopedia*, Copyright © 1969 by McGraw-Hill, Inc. All rights reserved. J. Markus, *Electronics and Nucleonics Dictionary*, 4th ed., Copyright © 1960, 1966, 1978 by McGraw-Hill, Inc. All rights reserved. J. Quick, *Artists' and Illustrators' Encyclopedia*, Copyright © 1969 by McGraw-Hill, Inc. All rights reserved. *Blakiston's Gould Medical Dictionary*, 3d ed., Copyright © 1956, 1972 by McGraw-Hill, Inc. All rights reserved. T. Baumeister and L. S. Marks, eds., *Standard Handbook for Mechanical Engineers*, 7th ed., Copyright © 1958, 1967 by McGraw-Hill, Inc. All rights reserved.

In addition, material has been drawn from the following references: R. E. Huschke, *Glossary of Meteorology*, American Meteorological Society, 1959; *U.S. Air Force Glossary of Standardized Terms*, AF Manual 11-1, vol. 1, 1972; *Communications-Electronics Terminology*, AF Manual 11-1, vol. 3, 1970; W. H. Allen, ed., *Dictionary of Technical Terms for Aerospace Use*, 1st ed., National Aeronautics and Space Administration, 1965; J. M. Gilliland, *Solar-Terrestrial Physics: A Glossary of Terms and Abbreviations*, Royal Aircraft Establishment Technical Report 67158, 1967; *Glossary of Air-Traffic Control Terms*, Federal Aviation Agency; *A Glossary of Range Terminology, White Sands Missile Range, New Mexico*, National Bureau of Standards, AD 467-424; *A DOD Glossary of Mapping, Charting and Geodetic Terms*, 1st ed., Department of Defense, 1967; P. W. Thrush, comp. and ed., *A Dictionary of Mining, Mineral, and Related Terms*, Bureau of Mines, 1968; *Nuclear Terms: A Glossary*, 2d ed., Atomic Energy Commission; F. Casey, ed., *Compilation of Terms in Information Sciences Technology*, Federal Council for Science and Technology, 1970; *Glossary of Stinfo Terminology*, Office of Aerospace Research, U.S. Air Force, 1963; *Naval Dictionary of Electronic, Technical, and Imperative Terms*, Bureau of Naval Personnel, 1962; *ADP Glossary*, Department of the Navy, NAVSO P-3097.

McGRAW-HILL DICTIONARY OF SCIENTIFIC AND TECHNICAL TERMS, Fifth Edition

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table) are bonded with carbon atoms in a cagelike network. { mə'tal-ō,kār-bə'hed,rēn }

metal locator See metal detector. { 'med-əl 'lō,kād-ər }

metallocene [ORG CHEM] Organometallic coordination compound which is obtained as a cyclopentadienyl derivative of a transition metal or a metal halide. { mə'tal-ə,sēn }

metallocycle [ORG CHEM] A compound whose structure consists of a cyclic array of atoms of which one is a metal atom; frequently the ring contains three or four carbon atoms and one transition-metal atom. { mə'tal-ə,sī-kəl }

metalogenic province [GEOL] A region characterized by a particular mineral assemblage, or by one or more specific types of mineralization. Also known as metallographic province. { mə'tal-ə'jen-ik 'präv-əns }

Metallogenium [MICROBIO] A genus of bacteria of uncertain affiliation; coccoid cells that attach to substrate; they germinate directly or form groups of elementary bodies by budding, and filaments form from these bodies. { mə'tal-ə'jē-nē-əm }

metallograph [OPTICS] An optical microscope equipped with a camera for both visual observation and photography of the structure and constitution of a metal or alloy. { mə'tal-ə,graf }

metallographic province See metallogenic province. { mə'tal-ə,graf-ik 'präv-əns }

metallographic test [MET] A test to determine the structural composition of a metal as shown at low and high magnification and by x-ray diffraction methods; tests include macroexamination, microexamination, and x-ray diffraction studies. { mə'tal-ə,graf-ik 'test }

metallography [MET] The study of the structure of metals and alloys by various methods, especially by the optical and the electron microscope, and by x-ray diffraction. { ,med-əl'äg-rä-fē }

metalloid [CHEM] An element whose properties are intermediate between those of metals and nonmetals. Also known as semimetal. { 'med-ə,lōid }

metallophobia [PSYCH] An abnormal fear of metal or metallic objects. { me,tal-ə'fō-bē-ə }

metalloporphyrin [BIOCHEM] A compound, such as heme, consisting of a porphyrin combined with a metal such as iron, copper, silver, zinc, or magnesium. { mə'tal-ə'pōrf-ərən }

metalloprotein [BIOCHEM] A protein enzyme containing a metallic atom as an inherent portion of its molecule. { mə'tal-ə'prō,tēn }

metallostatic pressure [MET] Pressure developed within a volume of molten metal. { mə'tal-ə,stad-ik 'presh-ər }

metallothionein [BIOCHEM] A group of vertebrate and invertebrate proteins that bind heavy metals; it may be involved in zinc homeostasis and resistance to heavy-metal toxicity. { mə'tal-ə'thī-ə,nēn }

metallurgical balance sheet [MET] Material balance of a metallurgical process. { ,med-əl'ərjə-kəl 'bal-əns,shēt }

metallurgical coke [MATER] Coke resulting from high-temperature retorting of suitable coal; a dense, crush-resistant fuel for use in shaft furnaces. { ,med-əl'ərjə-kəl 'kōk }

metallurgical dust [MET] A mixture of particles of elements and nonmetallic and metallic compounds. { ,med-əl'ərjə-kəl 'däst }

metallurgical engineer [ENG] A person who specializes in metallurgical engineering. { ,med-əl'ərjə-kəl ,en-jə'nir }

metallurgical engineering [ENG] Application of the principles of metallurgy to the engineering sciences. { ,med-əl'ərjə-kəl ,en-jə'nir-ij }

metallurgical fume [MET] A mixture of fine particles of elements and metallic and nonmetallic compounds either sublimed or condensed from the vapor state. { ,med-əl'ərjə-kəl 'fyūm }

metallurgical microscope [ENG] A microscope used in the study of metals, usually optical. { ,med-əl'ərjə-kəl 'mīkrə,sköp }

metallurgy [SCI TECH] The science and technology of metals and alloys. { ,med-əl'ərjē }

metal mining [MIN ENG] The industry that supplies the various metals and associated products. { 'med-əl ,mīn-ij }

metal-nitride-oxide semiconductor [SOLID STATE] A semiconductor structure that has a double insulating layer; typically, a layer of silicon dioxide (SiO₂) is nearest the silicon substrate, with a layer of silicon nitride (Si₃N₄) over it. Abbreviated MNOS. { 'med-əl 'nī,trīd 'äk,sīd 'sem-i-kən,däk-tər }

metal-organic chemical vapor deposition [SOLID STATE] A

technique for growing thin layers of compound in which metal organic compounds, having th where M is a group III metal and R is an org decomposed near the surface of a heated substr presence of a hydride of a group V element MOCVD. { 'med-əl ör'gan-ik 'kem-ə-kəl 'vā-ən }

metal oxide resistor [ELEC] A metal-film r an oxide of a metal such as tin is deposited as insulating substrate. { 'med-əl 'äk,sīd 'ri'zistər }

metal oxide semiconductor [SOLID STATE] tor semiconductor structure in which the insula oxide of the substrate material; for a silicon sub lating layer is silicon dioxide (SiO₂). Abb { 'med-əl 'äk,sīd 'sem-i-kən,däk-tər }

metal oxide semiconductor integrated circ An integrated circuit using metal oxide semico tors; it can have a higher density of equivalence bipolar integrated circuit. { 'med-əl 'äk,sīd 'se 'int-ə,gräd-əd 'sær-kət }

metal oxide semiconductor field-effect [ELECTR] A field-effect transistor having a gate from the semiconductor substrate by a thin laye oxide. Abbreviated MOSFET; MOST; MOS

merly known as insulated-gate field-effect trans al 'äk,sīd 'sem-i-kən,däk-tər 'fēld i,fekt tran'zist

metal-petal basket See cementing basket. { ,bas-kət }

metal plating See plating. { 'med-əl 'plād-ij }

metal pointing See pointing. { 'med-əl ,pōint-ij }

metal powder [MET] A finely divided metal or al ,paūd-ər }

metal replacement See immersion plating. { mōnt }

metal-rich star [ASTRON] A star in which the (elements heavier than helium) to hydrogen is gr of the Hyades. { 'med-əl 'rich 'stär }

metal rolling See rolling. { 'med-əl ,rōl-ij }

metal screen [GRAPHICS] An intensifying sc of a metal which emits secondary electrons and bombarded by x-rays. { 'med-əl 'skrēn }

metal semiconductor field-effect transistor field-effect transistor that uses a thin film of gal with a Schottky barrier gate formed by deposi metal directly onto the surface of the film. Abb FET. { 'med-əl 'sem-i-kən,däk-tər 'fēld i,fekt tr

metal-slitting saw [MECH ENG] A milling cut circular saw blade but sometimes with side teeth around the circumference; used for deep slotting cuts. { 'med-əl 'slid-ij 'sō }

metal spinning See spinning. { 'med-əl ,spīn-ij }

metal spraying [ENG] Coating a surface wi molten metal or alloy by using a compressor { 'med-əl 'sprā-ij }

metal-to-metal tap [COMMUN] A tapping proc actual contact is made with the target pair. { m əl 'tap }

metal vapor laser [OPTICS] An ion laser based tion of a solid or liquid metal, such as cadmium, cal lead, manganese, selenium, strontium, and tin, a buffer gas such as helium. { 'med-əl ,vāp-ər }

metamathematics [MATH] The study of the deductive logic as they are used in mathematical a ,math-ə'mad-iks }

metamer [ORG CHEM] One of two or more c pounds that exhibits isomerism with the others.

metamere [ZOO] One of the linearly arranged ments of the body of metameric animals. Also mite. { 'med-ə,mir }

metamerism [ZOO] The condition of an anni acterized by the repetition of similar segments exhibited especially by arthropods, annelids, and early embryonic stages and in certain specializ tures. Also known as segmentation. { mə'tam-

metamict [MINERAL] Of a radioactive minc lattice disruption due to radiation damage whil external morphology is retained. { 'med-ə,mīkt }

metamorphic aureole See aureole. { 'med-ə,mō-

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